2019 May 22 8:30am-10:10am JST

iachec-calstat@cfa.harvard.edu

Working Group IV.2 CalStat

8:30 — Guillaume Belanger

The most sensitive period search we can do on event data

Treating detection of transient phenomena as a statistical problem

9:00 — Vinay Kashyap

Flux measurement from high-resolution spectra

9:10 — Discussion: *A Practical Guide to Data Analysis*

9:25 — Discussion: modeling backgrounds

9:30 — Herman Marshall

Concordance

IACHEC 2019 May 22 : WG IV. 2

Flux Measurement from High-Resolution Spectra

Vinay Kashyap
CXC/CfA

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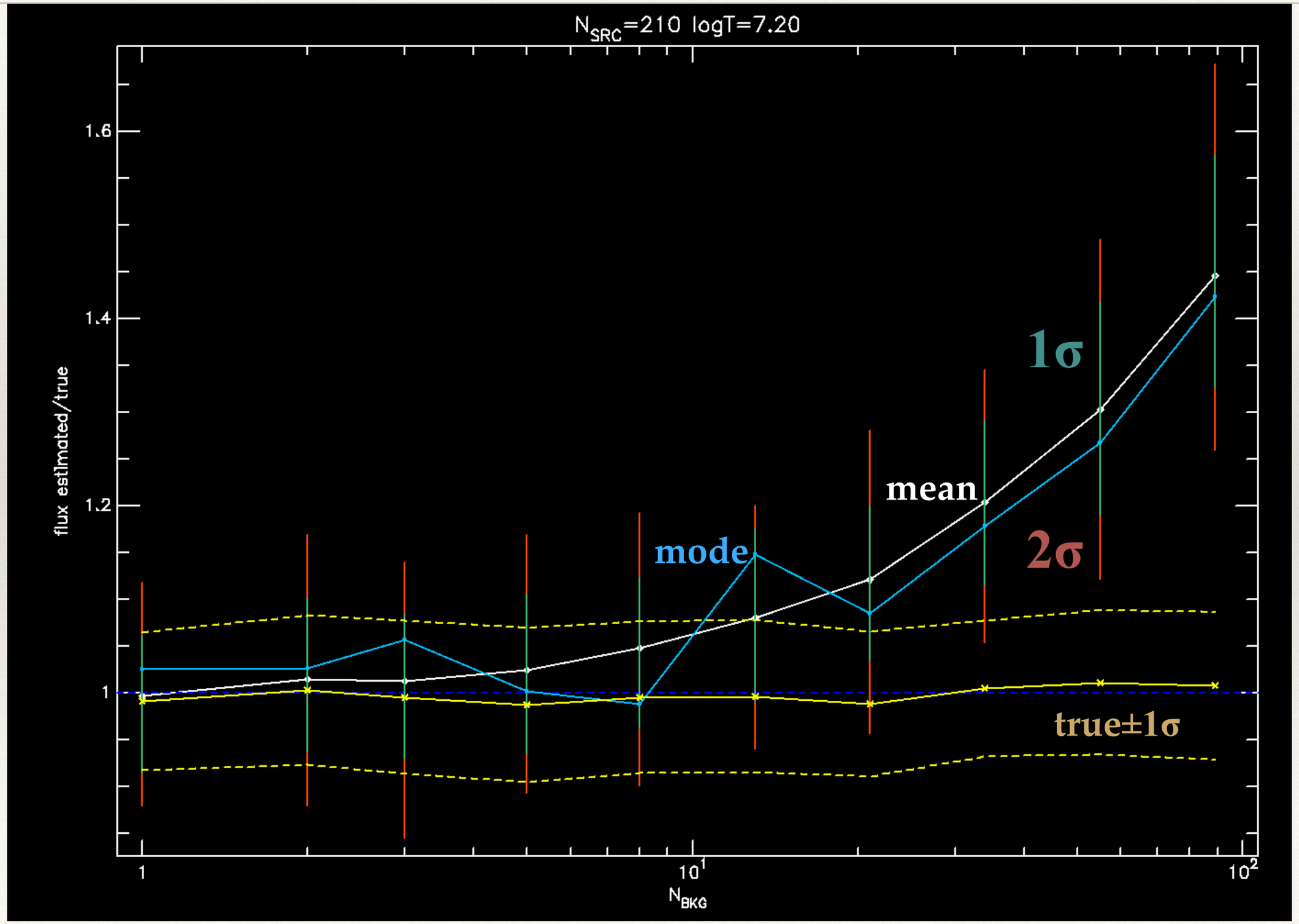
From Photons to Flux

Vinay Kashyap
CXC/CfA

If you add up the fluxes for all photons

- The obvious thing
  - Compute erg/cm^2 for each bin, add them up, divide by exposure time.
  - Works fine!
- But what if you have background? Observed counts are a mixture of true source events and background events (and you don't know which is which)
  - Again do the obvious thing — estimate what fraction of each count could be background and remove that fraction before estimating the flux
  - Does not work!

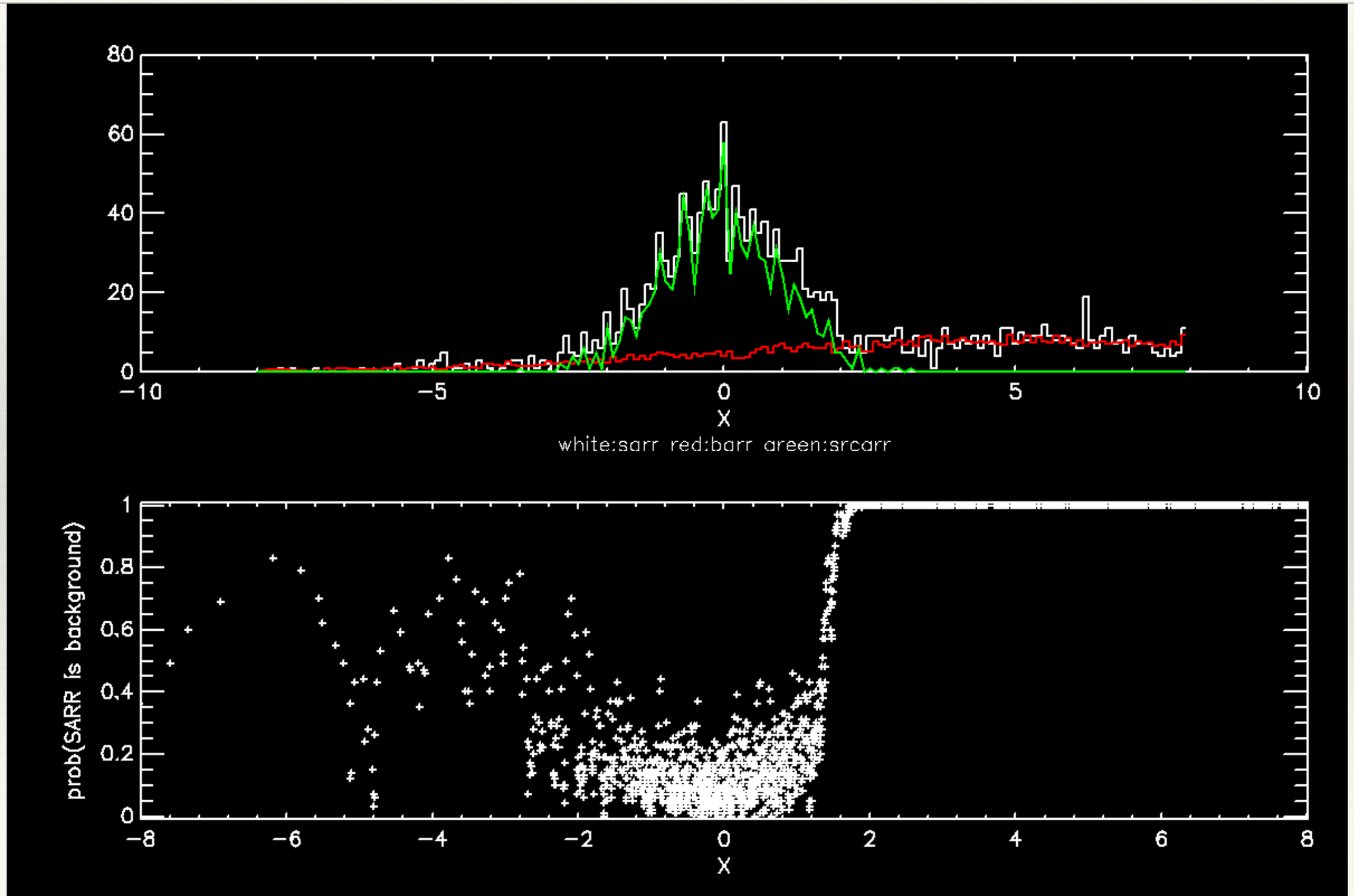
If you add up the fluxes



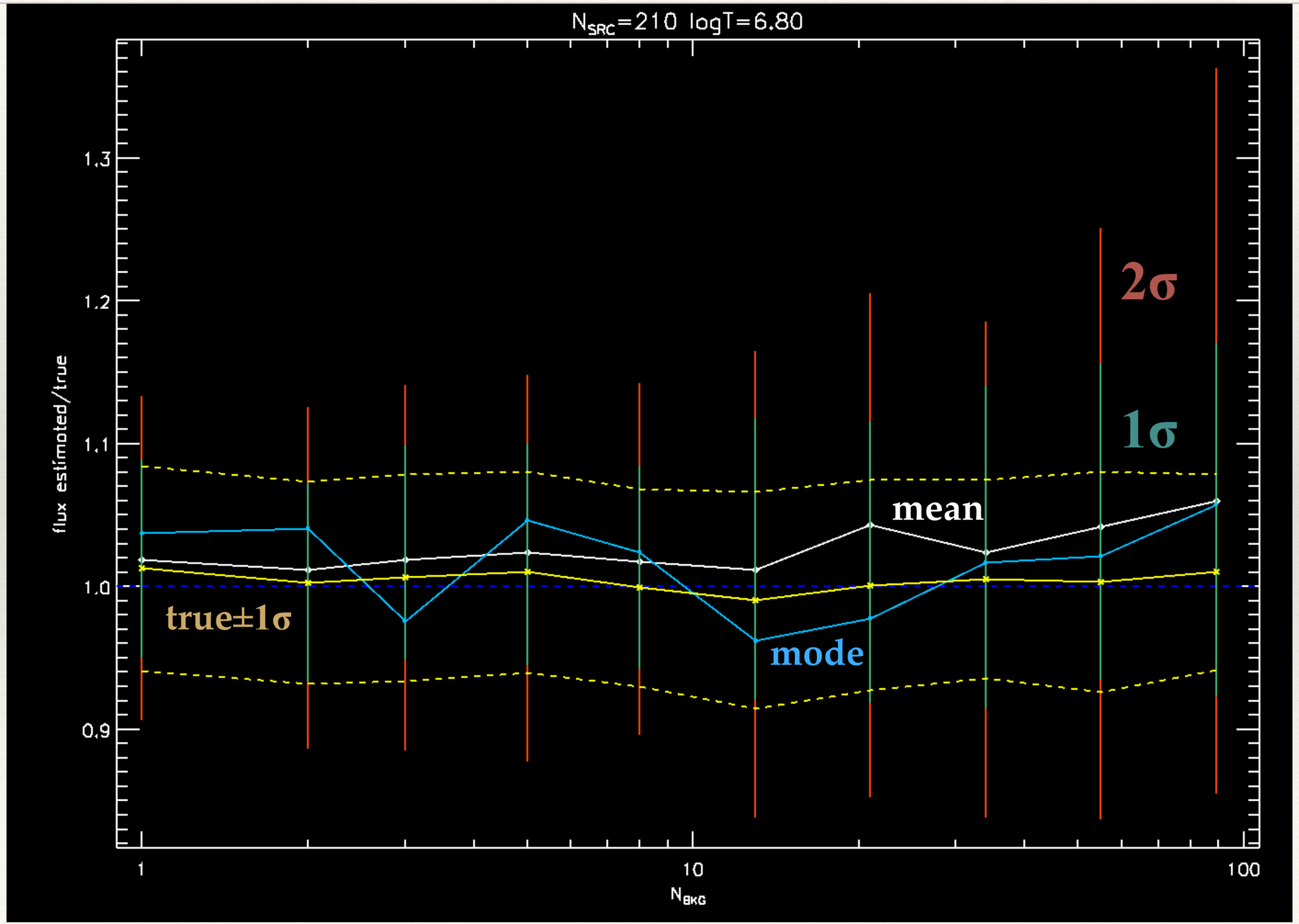
Dealing with background

- How about if we can figure out the probability that a given photon is from the background?
  - use Monte Carlo to randomly generate background events and superpose on observed spectrum
  - pick off the nearest event as background
  - repeat 100s of times, keep track of how many times a given observed count gets flagged — the more often, the higher the probability that it is a background event

example


80
60
40
20
0
−10
−5
0
5
10
X
white:sarr red:barr green:srcarr
1
0.8
0.6
0.4
0.2
0
prob(SARR is background)
−8
−6
−4
−2
0
2
4
6
8
X

Dealing with background



tl;dl

- If you add up photon energies when you know the energies accurately, background contamination will cause a large bias.
- There may be several mitigating strategies, but one that does work is to do Monte Carlo sampling based on assigned/computed probability that a given event comes from the background.

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A Practical Guide to Analysis

Vinay Kashyap
CXC/CfA

Action item from IACHEC 2018

Write a practical guide to best practices in X-ray analysis

Need co-authors!

And feedback!

A straw man ToC

1. What is this about
    1. An opinionated document
    2. listing things useful to cal scientists, and only things useful to cal scientists
2. Jargon and notation
    1. a dictionary of stats terms
3. On error bars
    1. there is a zoo of them (frequentist vs Bayesian, 1σ vs 90%, equal-tail vs highest posterior density)
    2. how to propagate, when propagation doesn't work
4. Sampling
    1. about pseudorandom numbers
    2. Distributions (are not functions)
    3. Monte Carlo and Bootstrap (types, what to be careful about)
    4. Tips and tricks

A straw man ToC (contd.)

5. Likelihood and Probability
    1. Conditional probability, Bayes' Theorem
6. Model Fitting
    1. Models, parameters, estimates, uncertainty intervals
    2. Non-parametric analysis (Kernel-density estimates, smoothing, histograms, Bayesian Blocks)
    3. log-Likelihood, chisq, Cash/cstat, Wstat — compare and contrast
    4. optimization techniques, MCMC
7. p-values and Hypothesis Tests
    1. What does a p-value mean and what it doesn't mean
    2. K-S test, F-test, Bayes Factors
    3. Examples: source detection
8. New Directions
    1. ML (Neural Networks, Gaussian Processes)

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